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NORTHCENTRAL UNIVERSITY
ASSIGNMENT COVER SHEET

Student: **Michael Higley-Vance**

THIS FORM MUST BE COMPLETELY FILLED IN

Follow these procedures: If requested by your instructor, please include an assignment cover sheet. This will become the first page of your assignment. In addition, your assignment header should include your last name, first initial, course code, dash, and assignment number. This should be left justified, with the page number right justified. For example:

DoeJXXX0000-1	1

Save a copy of your assignments: You may need to re-submit an assignment at your instructor's request. Make sure you save your files in accessible location.

Academic integrity: All work submitted in each course must be your own original work. This includes all assignments, exams, term papers, and other projects required by your instructor. Knowingly submitting another person's work as your own, without properly citing the source of the work, is considered plagiarism. This will result in an unsatisfactory grade for the work submitted or for the entire course. It may also result in academic dismissal from the University.

EDU7006-8 **Dr. Rebecca Watts**

Quantitative Research Design **Activity #3: Explore Experimental Designs I**

Comments: Was able to start working on questions using the books I already had and the provided articles. Received my textbook just in time on Saturday to complete the assignment Sunday afternoon.

Faculty Use Only

~~<Faculty comments here>~~Michael, thanks for submitting this assignment. It seems that you are making lots of calculations errors with the ANOVA problems. In several of the ANOVA problems, you did not calculate the degree of freedom value correctly. When you mis-calculate the degree of freedom, then the F-value will not be correct because the Mean Square values are not calculated. When you do not calculate the degree of freedom values correctly, then you will obtain the incorrect critical values for F. Similarly,

when using the incorrect values for degree of freedom, you will calculate the incorrect values for HSD and therefore your post-hoc analyses will not be correct. I don't understand how you are mis-calculating these values. The formulae for calculating the values are very straightforward and I don't understand how you are obtaining the incorrect values for the degree of freedom. Michael, make sure that you identify the correct formula for calculating the different quantities and make sure that you substitute values into those formula correctly. Then, make sure that you calculate correctly. If you have questions or do not understand the formula or how to calculate quantities, I will be glad to help you. The information is found in the textbook. Read the chapters carefully for an understanding of the concepts. I made lots of comments in your paper and I provided the correct calculations for some of the problems. Please let me know if you have any questions.

Score = 82

<Faculty Name> <Grade Earned> <Writing Score> <Date Graded>

Numerical Points	Letter Grade	Descriptor	Explanation
100 - 94	**A**	**Excellent**	Completes **all** required parts of the assignment, demonstrates **deep** understanding of materials, uses **very** clear and effective expression appropriate to scholarly writing, and has **very few or no** errors in grammar, mechanics, and APA formatting.
93-90	**A-**		
89-87	**B+**	**Good**	Completes **all or most** required parts of the assignment, demonstrates **good** understanding of readings, uses **mostly** clear and effective expression appropriate to scholarly writing, and has **few** errors in grammar, mechanics, and APA formatting.
86-83	**B**		
82-80	**B-**	**Fair**	Completes **most** required parts of the assignment, demonstrates **some** understanding of readings, and writing is **somewhat** clear, effective , and scholarly, and has **some** errors in grammar, mechanics, and APA formatting.
79-77	**C+**		
76-73	**C**	**Poor**	Completes **some** required parts of the assignment, demonstrates **some** understanding of readings, and writing is **difficult to understand** and **unscholarly**

			and has several errors in grammar, mechanics, and APA formatting.
72-0	**F**	**Unacceptable**	Completes few required parts of the assignment, demonstrates little understanding of readings, and writing is difficult to understand and unscholarly and has many errors in grammar, mechanics, and APA formatting.

Explore Experimental Designs I

1. Jackson, even-numbered Chapter Exercises, pp. 308-310.

   - Question 2. What is the difference between a randomized ANOVA and a repeated measures ANOVA? An ANOVA measures both types of correlated-group designs, which are within-subjects design and a matched-subjects design. A one-way randomized ANOVA is used when data represents a ratio or interval and is from a correlated-group design representing two or more independent groups, which are randomly assigned participants measuring only one dependent variable. A repeated measures ANOVA reports on (1) changes in mean scores over three or more time points, or (2) differences in mean scores under three or more different conditions. In repeated measures ANOVA, the independent variable has categories called levels or related groups and measures are repeated over time (Jackson, 2012).

   - Question 4. If a researcher decides to use multiple comparisons in a study with three conditions, what is the probability of a Type I error across these comparisons? Use the Bonferroni adjustment to determine the suggested alpha level. The suggested alpha level to reduce the probability of a Type I error is .017 however, this does increase the probability of a Type II error (Jackson, 2012).

     "A t test is used to compare performance between each of the two groups. If we do three experiments and do three comparisons, we need to do three t tests to determine the differences. The problem is that using multiple tests inflates the Type I error rate. Remember, a Type I error means that we reject the null hypothesis when we should have failed to reject it; that is, we claim that the independent variable has an effect when it does not. For most statistical tests, we use the 0.05 alpha (α) level, meaning that we are willing to accept a 5% risk of making a Type I error. Although the chance of making a Type I error on one t test is 0.05, the overall chance of a Type I error increases as more tests are conducted. To determine the chance of a Type I error when making multiple comparisons, we use the formula $1-(1-\alpha)^c$, where α refers to the acceptable probability of a Type I error (0.05) and c equals the number of comparisons performed. Using this formula for a study with three conditions, we get

$1-(1-0.05)^3 = 1-(0.95)^3 = 1-0.86 = 0.14$. Thus, the probability of a Type I error on at least one of the three tests is 0.14, or 14%. One way of counteracting the increased chance of a Type I error is to use a more stringent alpha level. The Bonferroni adjustment, in which the desired alpha level is divided by the number of tests or comparisons, is typically used to accomplish this. If we are using the *t*-test to make the three comparisons we would divide 0.05 by 3 and get 0.017. By not accepting the result as significant unless the alpha level is 0.017 or less, we minimize the chance of a Type I error when making multiple comparisons" (Jackson, 2012, p. 282).

- Question 6. When should post hoc comparisons be performed? Post hoc tests are designed for situations in which the researcher has already obtained a significant f-test with a factor that consists of three or more means. Additionally, exploration of the differences among means is needed to provide specific information on which means are significantly different from each other (Jackson, 2012).

- Question 8. Why is a repeated measures ANOVA statistically more powerful than a randomized ANOVA? A repeated-measures design is statistically more powerful than a randomized ANOVA because, it controls for factors that cause variability between subjects. The repeated-measures test separates between-subject variability from within-subject variability. If these matches are effective, the repeated-measures test will yield a smaller P value than a randomized ANOVA. If the pairing is ineffective, the repeated-measures test can be less powerful because it has fewer degrees of freedom (Jackson, 2012).

"With a one-way repeated measures ANOVA, participants in different conditions are equated prior to the experimental manipulation because the same subjects are used in each condition. This means that the single largest factor contributing to error variance (individual differences across subjects) has been removed. This also means that the error variance will be smaller. If the error variance is smaller, the resulting F-ratio will be larger. The end result is that repeated measures ANOVA is more sensitive to small differences between groups which makes the repeated measures ANOVA a statistically more powerful than a randomized ANOVA" (Jackson, 2012, p. 300).

- Question 10. In a study of the effects of stress on illness, a researcher tallied the number of colds people contracted during a 6 month period as a function of the amount of stress they reported during the same period. There were three stress levels: minimal, moderate, and high stress. The sums of squares appear in the following ANOVA summary table. The mean for each condition and the number of subjects per condition are also noted.

Source	Df	SS	MS	f
Between Groups	2	22.167	11.0835	6.76
Within Groups	9	14.750	1.639	
TOTAL	11	36.917	3.356	

Stress Level	Mean	N
Minimal	3	4
Moderate	4	4
High	6	4

A) Complete the ANOVA summary table. (see above table)

B) Is F_{obt} significant at a=.05, or at a=.01 The F_{obt} is significant at a=.05 with 6.76>4.26 but is not significant at a=.01 with 6.76<8.02.

C) Perform post hoc comparisons if necessary.
- Min – Mod = -1>-1.562
- Min – High = -3<-1.562
- Mod – High = -2<-1.562[1]

$HSD_{.05} = Q(k, df_{within}) \sqrt{(MS_{within}/n)}$

k = number of means being compared

Q value using Table A.9 in Appendix A

Tukey's Post Hoc Test	0.050	0.010
$Q(3,9)$	3.950	5.430
MS_{within}	1.639	1.639
n	4.000	4.000
HSD	**2.528**	**3.456**

D) What conclusions can be drawn from the F ratio and the post hoc comparisons? Using the F ratio there is a significant effect on stress levels when someone has a

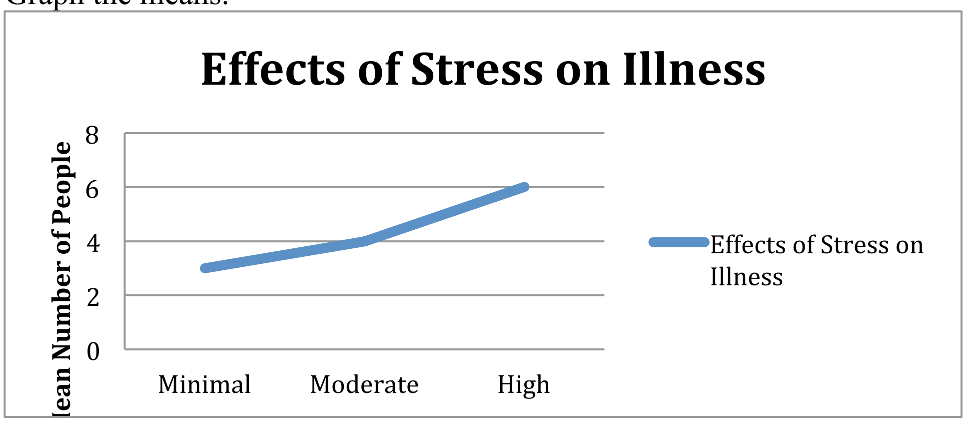
cold. Using the post hoc test tells us that there is a significant difference between the minimal and moderate groups but not between any of the other two.

The only difference between the minimal and high stress conditions is significant at $\alpha = 0.05$ level. All other comparison conditions are not statistically significant. Therefore, those who have high levels of stress are much more likely to get colds than those with either moderate or low levels of stress (Jackson, 2012).

E) What is the effect size? What does it mean? There is a 60% of the total variance is accounted for by the treatment effect. We can conclude that there is a large mean difference between each group, somewhere.

The effect size eta-squared (η^2) is a measure of effect size, the variability in the dependent variable attributable to the independent variable (Jackson, 2012).
$\eta^2 = SS_{between} / SS_{total} = 22.167 / 36.917 = 0.600$ meaning that approximately 60% of the variance among the colds can be attributed to the level of stress.

F) Graph the means.



- Question 12. A researcher conducted an experiment on the effects of a new "drug" on depression. The researcher had a control group that received nothing, a placebo group and an experimental group that received the "drug". A depression inventory that provided a measure of depression on a 50 point scale was used (50 indicates that an individual is very high on the depression variable). The ANOVA summary table appears next, along with the mean depressing score for each condition.

Source	Df	SS	MS	f
Between Groups	14[2]	1,202.313	85.9	1.216
Within Groups	30	2,118.00	70.6	
TOTAL	44	3,320.313		

Source ***df*** ***SS*** ***MS*** ***F***

Between groups	**2**	**1,202.313**	**601.157**	**11.921**
Within groups	**42**	**2,118.00**	**50.429**	
Total		**3,320.313**		

***"Drug"* Condition**	**Mean**	**N**
Control	36.26	15
Placebo	33.33	15
"Drug"	24.13	15

A) Complete the ANOVA summary table. (see table above)

B) Is f_{obt} significant at a = .05; at = .01? The f_{obt} is not significant at either the .05 with an f_{cv} = 2.09 and at 0.01 with f_{cv} = 2.84 because 1.216 < 2.09 and 2.84. Therefore, because the calculated value is less than the critical value at .05 and .01 the null hypothesis fails to be rejected.

This would be the correct conclusion based on the F-value that you calculated. However, with the correct value of F, we would reject the null hypothesis.

C) Perform post hoc comparisons if necessary.

- Con - Plac = 2.93>.24659
- Con - Drug = 12.13>.24659
- Plac - Drug = 9.2>.24659

$HSD_{.05} = Q(k, df_{within}) \sqrt{(MS_{within}/n)}$

k = number of means being compared

n = the number of participants in each group

Q value using Table A.9 in Appendix A

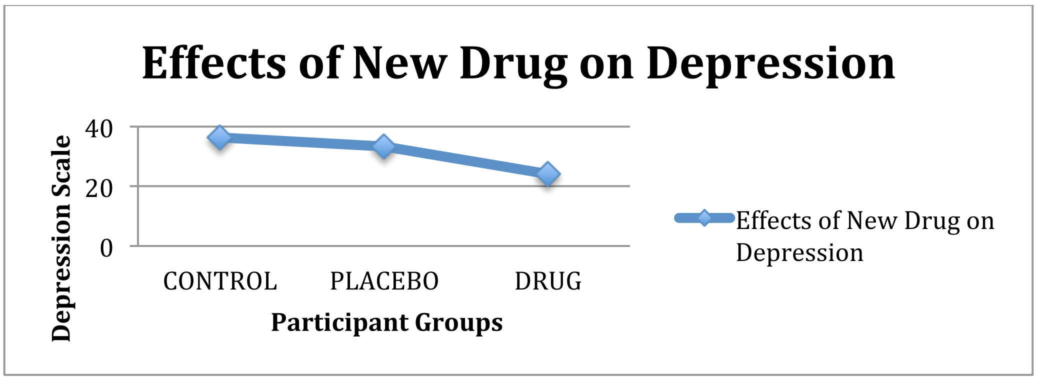
Tukey's Post Hoc Test	0.050	0.010
$Q(3,42)$	3.440	4.370
MS_{within}	50.429	50.429

n	15.000	15.000
HSD	**6.307**	**8.013**

D) What conclusions can be drawn from the F ration and the post hoc comparisons? Using the f ratio there is no significant difference in the between group compared to the within group. However, using the post hoc test researchers can conclude that there was a significant difference between the control and placebo, control and drug and placebo and drug. More specifically there was a significant decrease in the feeling of depression in participants who took the new "drug."

E) What is the effect size, and what does this mean? 36% of the total variance is accounted for by the treatment effect. We can conclude that there is less than 40% mean difference between each group.

F) Graph the means.



- Question 14. A researcher has been hired by a pizzeria to determine which type of crust customers prefer. The restaurant offers three types of crust: hand tossed, thick, and thin. Following are the mean number of l inch pieces of pizza eaten for each condition from 10 subjects who had the opportunity to eat as many pieces with each type of crust as they desired. The ANOVA summary table also follows.

Source	Df	SS	MS	f
Subject	7	2.75	.39	
Between	2	180.05	90	58.44
Error	14	21.65	1.54	
TOTAL	23	204.45		

Source	*df*	*SS*	*MS*	*F*

Subject	**9**	**2.75**	**0.306**	
Between	**2**	**180.05**	**90.025**	**74.838**
Error	**18**	**21.65**	**1.203**	
Total	**29**	**204.45**		

Crust Type	**Mean**	**N**
Hand-tossed	2.73	10
Thick	4.20	10
Thin	8.50	10

A) Complete the ANOVA summary table. (see table above)

B) Is F_{obt} significant at a = .05; at a = .01? The f_{obt} is significant at both the .05 with an f_{cv} = 3.74 and at 0.01 with f_{cv} = 6.51 because 58.44 > 3.74 and 6.51. Therefore, the null hypothesis is rejected because the calculated value of 58.44 is greater than the critical values at .05 and .01.

C) Perform post hoc comparisons if necessary. I don't understand your comparisons.

- Hand – Thick = -09991 > -.25617
- Hand – Thin = -3.9215 > -10.055
- Thick – Thin = -2.9224 > -7.493

$HSD_{.05} = Q(k, df_{error})\sqrt{(MS_{error}/n)}$

$HSD_{.01} = Q(k, df_{error})\sqrt{(MS_{error}/n)}$

k = number of means being compared

Q value using Table A.9 in Appendix A

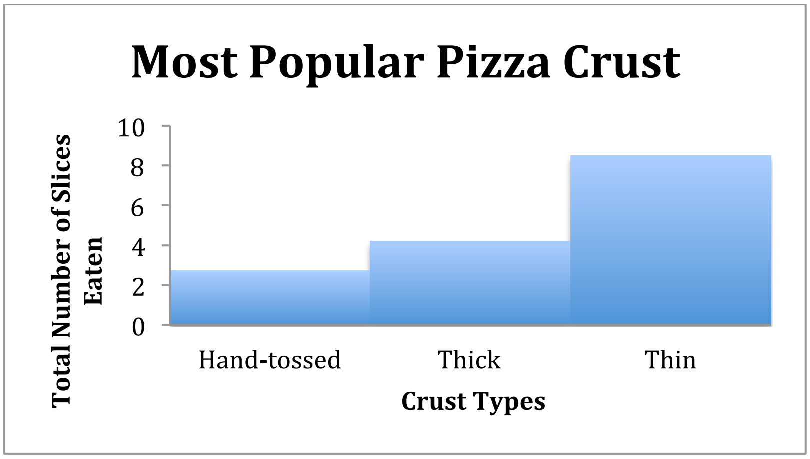
Tukey's Post Hoc Test	0.050	0.010
$Q(3,18)$	3.610	4.700
MS_{error}	1.203	1.203
n	10.00	10.00

HSD **1.252** **1.630**

D) What conclusions can be drawn from the F ratio and the post hoc comparisons? The f ratio tells the researcher that there is a significant difference between the types of pizza crusts and the post hoc comparisons indicates which pizza crust is the most popular. Which groups differ?

G) What is the effect size, and what does this mean? 11% of the total variance is accounted for by the treatment effect. How did you calculate the effect size?

E) Graph the means.



2. What is an F-ratio? Define all the technical terms in your answer. The F-ratio is the ratio of the variance between groups to the variance within groups. The F-ratio is used to test whether or not two variances are equal. The F-ratio is calculated as follows: F = between-groups variance ÷ within-groups variance = system variance + error variance ÷ error variance.

3. What is error variance and how is it calculated? Error variance is the result of random differences among participant scores caused by chance or under controlled situations. Error variance is the portion of the total variance in a set of data that remains unaccounted and variance that is unrelated to the variables under investigation in a study (Jackson, 2012). Error variance can be estimated by identifying the amount of variability within each condition. $\mu = E[X]$: $Var(x) = E[(X - \mu)^2]$.

4. Why would anyone ever want more than two (2) levels of an independent variable? Having more than one independent variable is much more efficient and effective to an experiment. Using multiple independent variables allow a researcher to study the interactions among the independent variables. However, researchers who use multiple

independent variables are unable to draw a correlation between those the independent variable and the cause of change in the dependent variable (Jackson, 2012).

Examining more levels of an independent variable allows us to address more complicated and interesting questions (Mitchell & Jolley, 2004). Often experiments begin as two-group designs and then develop into more complex designs as the questions asked become more elaborate and sophisticated. Researchers may decide to use a design with more than two levels of an independent variable for three reasons. First, it allows them to compare multiple treatments. Second, it enables them to compare multiple treatments with n treatment (the control group). Third, more complex designs allow researchers to compare a placebo group with control and experimental groups (Mitchell & Jolley, 2004). We can introduce more conditions and test these conditions. Perhaps the best alternative may not be one of two options, but perhaps one of several options.

5. If you were doing a study to see if a treatment causes a significant effect, what would it mean if within groups variance was higher than between groups variance? If between groups variance was higher than within groups variance? Explain your answer. In an ANOVA it would likely mean that there was no significant F test (if within group variance is higher than between group variance). This means that the variable in the question had no real effect (Jackson, 2012). Within group variance is the error term (SSwithin or SSerror) and the between group effect SS term (SSbetween). Therefore, SSbetween/SSwithin is the omnibus F test that tells you if the independent variable has any effect. If between group variance is greater than within group variance, then we would expect F to be larger and therefore expect a significant difference.

6. What is the purpose of a post-hoc test with analysis of variance? The purpose of a post hoc test is to determine the significant differences among three or more means.

7. What is probabilistic equivalence? Probabilistic equivalence means that the type of equivalence a researcher uses is based on the notion of probabilities (Trochim, 2006). Probabilistic equivalence is achieved when groups are randomly assigned. Randomly assigning groups means that researchers can calculate the chance two groups will differ (Trochim & Donnelly, 2008). Why is it important? Probabilistic equivalence is important because when researchers randomly assign, they are able to conclude that groups have a form of equivalence. The groups are not expected to be equal but when they are randomly assigned they can be expected to be probabilistically equal (Trochim & Donnelly, 2008).

References

Jackson, S. L. (2012). *Research methods and statistics: A critical thinking approach*. Belmont, CA: Wadsworth Cengage Learning.

Trochim, William M. (October 20, 2006). The Research Methods Knowledge Base, 2nd Edition. Retrieved from http://www.socialresearchmethods.net/kb/expequi.php

Trochim, W. M., & Donnelly, J. P. (2008). *Research methods knowledge base*. Mason, OH: Atomic Dog/Cengage Learning.